NOTE *Internal Medicine*

Characteristics of Esophageal Diverticula Using Computed Tomography and Three-Dimensional Reconstruction in a Maltese Dog

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ABSTRACT. A 7-year-old intact female Maltese dog was referred with ptyalism and intermittent vomiting but no regurgitation for over 1 month. Survey radiographs including a contrast study revealed a large circular dilated cavity from the carina to the diaphragm. Additionally, multi-detector computed tomography and three-dimensional reconstruction were performed. These images revealed large idiopathic distal esophageal diverticula. This case report represents the first report using multi-detector computed tomography and three-dimensional reconstruction for evaluation of esophageal diverticula in a dog.

KEY WORDS: 3D reconstruction, canine, CT, esophageal diverticula.

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The use of multi-detector computed tomography (MDCT) and three-dimensional (3D) reconstruction for esophageal diseases, such as bronchoesophageal fistula, diverticula and tumor, have been actively studied in human medicine [1]. Imaging of the gastrointestinal tract, including the esophagus, became possible by using the MDCT technology with high-quality multi-planar reformation and visualization by 3D reconstruction [1, 10]. Also, CT has the ability to cover a large volume in a very short scan time [1]. This case report describes the characteristics of large esophageal diverticula diagnosed by CT and 3D reconstruction.

A 7-year-old, intact female Maltese dog weighing 1.3 kg was referred with chronic ptyalism and intermittent vomiting but no regurgitation for over 1 month. This dog had displayed progressive weight loss for the preceding few months. On physical examination, the dog did not have any oral and pharyngeal problems such as foreign body or structural abnormality, which can manifest with similar symptoms.

Initial diagnostic tests including complete blood count, serum biochemistry, electrolytes, and blood gas analysis were performed. All results were within reference ranges, except for mild normocytic-normochromic regenerative anemia (packed cell volume [PCV] 34%, reference range, 37%–55%) and increased serum amylase (732 U/*l*, reference range, 185–700 U/*l*).

Survey radiography of the thorax showed a large circular dilated soft-tissue density line from the carina to the diaphragm on both the right lateral and ventrodorsal views (Fig. 1). Abdominal radiography revealed a gas-filled stomach and intestine. The collective result prompted the suspicion of an esophageal foreign body, diverticula or mass. A contrast radiographic study and fluoroscopy were also performed with iohexol (2 m*l*/kg, Omnipaque™ 300 mg I/m*l*, GE Healthcare (Shanghai) Co., Ltd., Shanghai, China). Contrast images showed a large cavity with contrast agent cranial to the diaphragm that separated from the stomach immediately after administration (Fig. 2). And, 1 hr after administration, almost all the contrast agents were evident in the stomach and intestine, with little in the thoracic cavity. During fluoroscopy, contrast agents flowed into the cavity first, before entering the stomach with relatively decreased esophageal motility.

In this case, the whole esophageal structure was ambiguous, and the dilated area needed to be differentiated between the diverticula and esophagus itself. Therefore, thoracic and abdominal CT scan was performed the following day. MDCT was performed using an Asteion Super 4 apparatus (Toshiba, Tokyo, Japan). Plain transverse, sagittal and dorsal two-dimensional and post-contrast views were examined. The CT scan revealed large esophageal diverticula and mild megaesophagus along the length of the esophagus (Figs. 3 and 4). There was no evidence of existence of thymoma and other pleural problems such as aspiration pneumonia, fibrosis, perforation and foreign body. Also, according to a previous human study [9], none of the criteria for pleural adhesion, pleural thickening, enhancing bands or loculation of pleural effusion, visceral pleural retraction, empyema and band around pneumothorax, were present on CT images. Thus, pleural adhesion with surrounding tissues was excluded.

The result of an acetylcholine receptor antibody titer test for Myasthenia gravis (MG) was in the normal range (0.01 nmol/*l*, reference range, 0.0–0.6 nmol/*l*). A neostigmine response test (Neostigmine Methylsulfate Inj, 0.04

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Fig. 1. (A) Note the large circular dilated radiopaque line from the carina to the diaphragm on the right lateral plain view. (B) The large circular dilated radiopaque line is present on the ventrodorsal plain view. (Arrows)

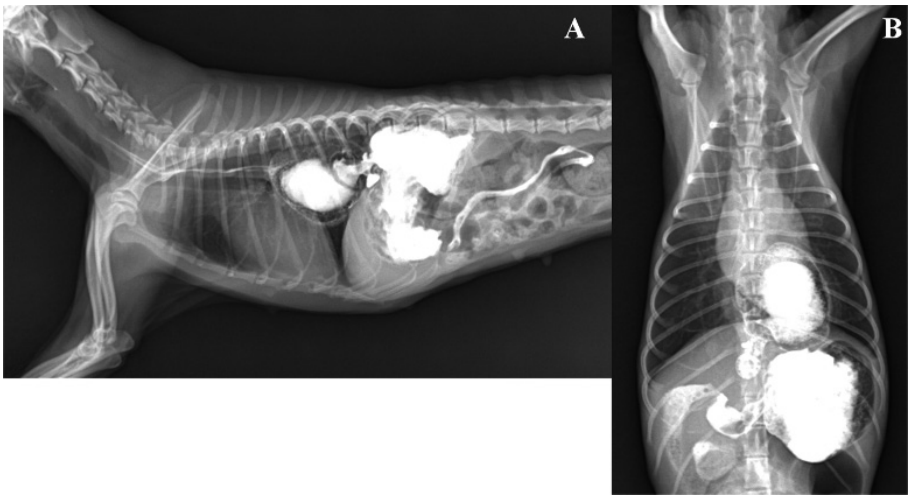

Fig. 2. (A and B) Immediately after administration of the contrast agent, a large cavity is evident in the thorax, and it is distinguished from the stomach on the right lateral view and ventrodorsal view.

mg/kg, intramuscularly; Dai Han Pharm., Seoul, Korea) to check indirectly for MG was performed. Neither diameter nor motility changes in the esophagus and diverticula were evident. Polymerase chain reaction for canine distemper virus, which can lead to neuromuscular symptoms including megaesophagus, produced negative results [4]. Based on the results of all the examinations, the esophageal diverticula in this dog appear to have been idiopathic.

To date, many possible causes of esophageal diverticula have been identified, including esophagitis, esophageal strictures, foreign bodies, megaesophagus, hiatal hernias and vascular ring anomalies [11]. Esophageal diverticula are rare conditions [4] and can be congenital or acquired via a sac-like outpouching in the esophageal wall [11]. By means of endoscopic and radiographic landmarks [8], esophageal diverticula are divided into three types by their location in humans [2, 6, 8]: cervical esophageal diverticula; mid-esophageal diverticula, which are located between the thoracic inlet and the heart base; and distal esophageal diverticula, which are located from the heart base to the gastroesophageal sphincter [2, 6, 8]. Additionally, there are more internal structures around the mid-esophageal location type of acquired diverticula, and the strategy for surgical repair may be affected [5].

Acquired esophageal diverticula are subclassified into pulsion and traction diverticula [11, 12]. Pulsion diverticula are caused by herniation of the mucosa through the esophageal muscular wall, which results in food retention

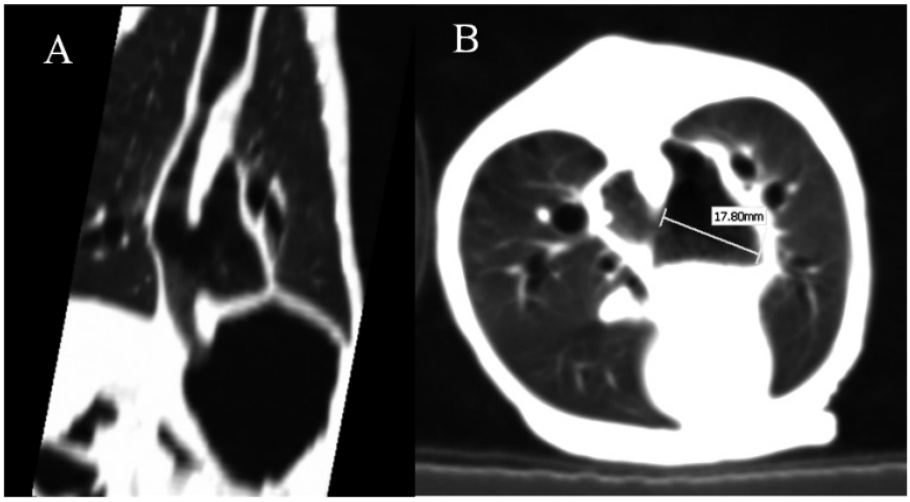

Fig. 3. (A) Two-dimensional computed tomography dorsal image of esophageal diverticula. (B) Two-dimensional computed tomography transverse image, lung window, post contrast. Maximum width of the diverticula is 17.80 mm. There was no distinct evidence of fistula, adhesion, foreign body or stricture.

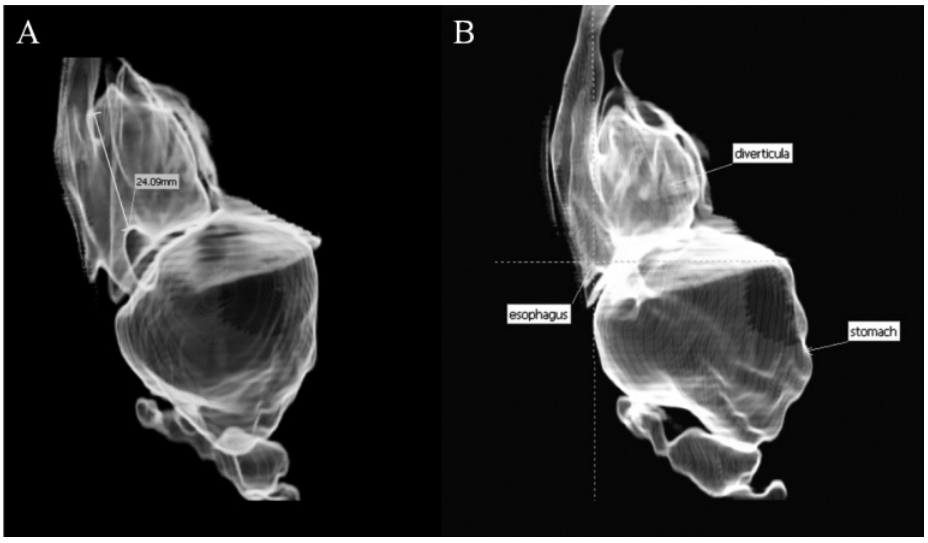

Fig. 4. Three-dimensional reconstruction of esophageal diverticula. The longest part of the opening of the diverticula length is 24.09 mm. The size and shape of the diverticula were estimated from these images.

within the diverticula [3]. Traction diverticula are caused by an extra-esophageal lesion [3]. A typical example of traction diverticula is the formation of an adhesion between the esophagus and other pleural structures, including the tracheal or hilar lymph nodes [3]. Based on these locations and classifications, this dog was judged to have pulsion distal esophageal diverticula.

Normally, esophageal diverticula are easy to diagnose using a traditional contrast esophagram. But, depending on the patient conditions, other diagnostic methods may be required. For example, other methods may be necessary when a contrast study solely cannot get enough full images to diagnose esophageal diverticula, such as in patients with severe regurgitation who throw up the contrast agent immediately; for patients who have a potential risk of aspiration pneumonia as a result of regurgitation, such as those who have severe esophageal hypomotility, dysautonomia or megaesophagus, after being given contrast agent; when the diverticula may be ambiguous and there is a need to distinguish it from other pleural conditions, including periesophageal inflammation, fibrosis, adhesions to adjacent tissue (e.g., lung, bronchus, hilar lymph node) [4, 9], tumors, achalasia, esophagitis, fistulas, duplication cyst or even hiatus hernia [1]; and, like in this patient, when the shapes of the suspected esophageal

diverticula on thoracic radiography are ambiguous when trying to identify the whole esophageal structure. In this situation, either CT or endoscopy may be needed for accurate diagnosis. These methods require the patient to undergo general anesthesia. However, CT and 3D reconstruction may provide similar intraluminal conditions and even give more information about extraluminal conditions than endoscopy. Also, the type of acquired esophageal diverticula can be assumed based on a CT scan but not based on endoscopy. Furthermore, CT is less invasive than endoscopy, because it does not require insertion of an instrument into the patient.

In conclusion, although there are some disadvantages of CT scan and 3D reconstruction including the requirement of general anesthesia, high cost and low availability at local animal hospitals, they can provide accurate information regarding the characterization of esophageal diverticula by allowing a less-invasive assessment and showing both the intraluminal and extraluminal extent of esophageal conditions compared with a traditional study [1, 7]. Overall, CT and 3D reconstruction also might be considered as diagnostic methods for esophageal diverticula in dogs for which it is difficult to perform a contrast study or when differentiation from other pleural conditions is required.

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